

APPENDIX

APPENDIX A

WATER QUALITY INDEX METHODOLOGY

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The rankings for the Water Quality Index (WQI) were developed utilizing data generated from monitoring activities conducted during 1982-83. Trend station data from the Division of Water primary ambient stations, joint Division of Water/U.S. Geological Survey stations, U.S. Geological Survey NASQAN stations and ORSANCO stations on tributary rivers to the Ohio River were retrieved for the two year period of this report and compiled by hydrologic units within a river basin. Categories in the WQI are:

- Dissolved oxygen
- pH
- Aesthetics (suspended solids)
- Trophic nutrients (TP and NO₂ and NO₃-N)
- Toxics (water quality parameters and sediment parameters)
- Bacteria (fecal coliform)
- Biological (algae, macroinvertebrates, fish, fish tissue parameters)

Each parameter within a category was assigned a point value according to the scheme; good=+1, Fair=0, and poor=-1. Parameters within each category were then averaged and an overall value was given to each category (-1 to +1). The categories were then summed to give a WQI value (-7 to +7) for each monitoring station.

In hydrologic units which had multiple monitoring stations, the final WQI point value was calculated as the weighted average of the individual stations. The weight variable was based on the total stream miles represented by each station. The final point values were then translated according to the scheme; good > +3, fair -3 to +3, and poor < -3.

In order to assign point values to the parameters in each category, screening criteria were developed for good, fair and poor ratings. The following list indicates the criteria used for the parameters in each WQI category with the exception of the Toxics (sediments) and Biological category.

Table A-1
Water Quality Index Screening Criteria

WQI Category	Screening Criteria	Source
Dissolved oxygen	4.0 mg/l	KSWS
pH	6-9 units	KSWS
Aesthetics (suspended solids)	80 mg/l	NAS Blue Book* (moderate level of protection for aquatic communities)

Table A-1 continued

WQI Category	Screening Criteria	Source
Trophic Nutrients		
TP	.147 mg/l	SOTRET state-wide mean from KY ambient stations for period of record
NO ₂ -NO ₃ -N	.72 mg/l	
Toxics		
Water		
Arsenic	50 ug/l	KSWS
Beryllium	1000 ug/l	KSWS
Cadmium	12 ug/l	KSWS
Chromium	100 ug/l	KSWS
Copper	6 u/gl	EPA chronic criteria**
Iron	1000 ug/l	KSWS
Nickel	120 ug/l	EPA chronic criteria**
Selenium	35 ug/l	EPA chronic criteria**
Silver	7 ug/l	EPA acute criteria**
Zinc	47 u/gl	EPA chronic criteria**
Un-ionized Ammonia	.05 ug/l	KSWS
Bacteria (fecal coliform)	400/100 mg/l	KSWS for primary contact recreation

* Kentucky Surface Water Standards for warmwater aquatic habitat use.

** Derived from EPA Water Quality Criteria documents, October 1980. Note: The hardness value of 136 mg/l was used for determining criteria levels for metals and was based on a STORET statewide mean.

The screening criteria were then used to evaluate the available data and to arrive at good, fair and poor rankings based on the method described below:

Ranking**Method****Good**

Criterion is exceeded in 0-10% of the analyses and the mean measured value is less than the screening value.

Fair

Criterion is exceeded in 11-25% of the analyses and the mean measured value is less than the screening value; or criterion is exceeded in 0-10% of analyses and mean measured value exceeds the screening value.

Poor

Criterion is exceeded in more than 25% of analyses and mean measured value is less than the screening value; or criterion is exceeded in 11-24% of analyses and mean measured value exceeds the screening criterion.

Toxics Sediments

Included in the toxics category were data from sediments collected at the trend stations (DOW primary stations & DOW/USGS) for 1982 (partial) and 1983 (all). Sediment values were compiled by station for each hydrological unit. All hydrological units were combined for each basin. Sediment data were evaluated by the following methods:

Parameters**Source of Screening Criteria****Metals**

Arsenic
Cadmium
Chromium
Copper

Mercury
Lead
Zinc
Iron

Nickel
Manganese

Guidelines for the Pollutational
Classification of Great Lakes
Harbor Sediments (U.S. EPA,
Region V, Chicago, IL, 1977)

Pesticides and PCB

Dieldrin
DDT

Chlordane
PCB

Evaluation of Illinois
Stream Sediment Data 1974-1980

The U.S. EPA classified sediments as unpolluted (good), moderately polluted (fair), and heavily polluted (poor). The Illinois study ranked in five categories, which were combined to three categories; non-elevated and slightly elevated = Good, Elevated = Fair, Highly Elevated, and Extremely Elevated = Poor. Points were assigned as previously mentioned for the good, fair, and poor rankings (see above).

Biological Quality

This portion of the 305(b) report characterizes the aquatic biota and the water quality at selected trend stations in Kentucky. The period of data collection and frequency at these stations is limited; therefore, the characterization of the stream depends on available data, stream side habitat observations and the biologist's interpretations.

Biological monitoring of the periphyton, macroinvertebrate and fish communities and tissue residues has been conducted annually during 1982 and 1983 at a total of ten primary network stations. The various parameters used as a basis for the biological assessment are generally the following:

- A. Species diversity, richness and pollution tolerance
- B. Community structure
- C. Biomass determination
- D. Productivity
- E. Tissue Residues

Periphyton quantitative sampling was accomplished by use of the Design Alliance Periphytometer. Qualitative samples were acquired by scraping selected stream substrates. Macroinvertebrate sampling consisted of deploying modified Hester-Dendy multiplate samplers for quantitative analyses. Select pickings from various stream habitats comprised the qualitative analyses. Stream size dictated the type(s) of fish collection methods. A variety of methods were used, including seining, passive netting, and electrofishing. The water quality at the biologically monitored stations is ranked as either good, fair or poor. These terms are defined as follows:

Ranking

Method

Good:

Waters that possess indigenous populations of aquatic organisms, unaltered in community structure for the available habitats with exceptional functional groupings and taxa richness. These stations most often contain species that are considered intolerant of sustained pollution.

Fair:

Waters that possess indigenous populations of aquatic organisms that show slight to moderate alterations in community structure. Taxa richness and species composition are often skewed or depressed (enough to be noted in relation to the available habitats). The community is dominated by facultative organisms and exhibit signs of stress due to pollution.

Poor:

Waters that possess indigenous populations of aquatic organisms that show moderate to severe alterations in

community structure for the available habitats. The community is dominated by tolerant and facultative organisms. Taxa richness and species composition are radically skewed and/or depressed in favor of tolerant organisms. These communities are obviously under stress from sustained pollution.

Unknown:

Stations at which biological information is insufficient.

Attempts were made to determine if the aquatic communities at each of the stations were impaired, partially impaired or unimpaired during the sample period (1982-1983). However, it should be recognized that climatological conditions and loss of samplers due to vandalism have created sampling problems. On the other hand, the addition of personnel and improvement of the staff's taxonomic skills have improved data interpretation. Two stations have monitoring data spanning five years and therefore a trend analysis was possible. These factors, plus the lack of a historical data base, limits accurate trend analyses; however, these problems should be resolved with continued data collection at these locations.

Fish tissue values were ranked by station and averaged by hydrological unit and basin. The following parameters and rating criteria are based on literature review and were used for the fish tissue evaluation.

Pesticides and PCB

	<u>Good</u>	<u>Fair</u>	<u>Poor</u>
Aldrin	< 0.1 mg/kg	values between good and poor	> .30 mg/kg
Dieldrin	< 0.1 mg/kg	values between good and poor	> .30 mg/kg
DDT	< 1.0 mg/kg	values between good and poor	> 5.0 mg/kg
Chlordane	< 0.1 mg/kg	values between good and poor	> .30 mg/kg
PCP	ND		ND
Toxaphene	< 0.1 mg/kg	values between good and poor	> 5.0 mg/kg
PCB	< 0.5 mg/kg	values between good and poor	> 5.0 mg/kg

Good values are based on recommendations for organochlorine insecticide fish residues in the NAS Blue Book pp. 185-186.

Fair values range between good to poor rating.

Poor values are based on FDA action levels.

Metals:

	<u>Good</u>	<u>Fair</u>	<u>Poor</u>
Arsenic	< .5 mg/kg	values between good and poor	> 5.0 mg/kg
Cadmium	< .15 mg/kg	no value	> .15 mg/kg
Chromium	ND	ND	ND
Copper	< 10.0 mg/kg	values between good and poor	> 100.0 mg/kg
Mercury	< .5 mg/kg	values between good and poor	> 1.0 mg/kg
Lead	< 0.1 mg/kg	values between good and poor	> 5.0 mg/kg
Zinc	< 0.5 mg/kg	values between good and poor	> 5.0 mg/kg

Good

- o As, Cd, and Pb values are based on U.S. Fish and Wildlife Service (USFWS) mean background levels for fish tissue. National Pesticide Monitoring Program - Luke & Schmitt, pp. 97-110. 3rd USA-USSR Symposium on Effects of Pollutants upon Aquatic Life. 1979.
- o Zn and Cu values estimated as 0.10 of poor value.
- o Hg value based on recommendation in NAS Blue Book pg. 174.

Fair - range of value between good and poor limits

Poor - As, Cu, Pb and Zn based on federal Canadian values for fish tissue from Tsui and McCart - "Chlorinated Hydrocarbon Residues and Heavy Metals in Several Fish Species from the Cold Lake Area in Alberta, Canada" in International Journal of Environmental and Analytical Chemistry. 1981 Vol. 10, pp. 277-285.

- o Hg value derived from FDA action level.
- o Cd value estimated from Kentucky background data and best professional judgement.

ND - Not determined/insufficient data for decision.

APPENDIX B

RIVER BASIN/HYDROLOGIC UNIT INFORMATION

BIG SANDY RIVER BASIN

The Big Sandy River basin lies in the rugged mountains of the Cumberland Plateau in eastern Kentucky and adjacent West Virginia and Virginia. The basin is underlain by sandstone deposits of Pennsylvanian age. There are 1,257 miles of streams in the basin depicted on the USGS hydrologic unit map. The total drainage area is 4,280 square miles, 2,885 of which are in Kentucky.

The main stem of the Big Sandy River originates at the confluence of Levisa and Tug forks at Louisa, Kentucky, and flows north 27 miles to enter the Ohio River (mile 317.1) at Catlettsburg, Kentucky. Levisa Fork flows 130 miles in Kentucky with a drainage area of 1,471 square miles. Principal tributaries of the Levisa Fork include Paint Creek, Russell Fork, Beaver Creek, and Johns Creek. Tug Fork forms the boundary between Kentucky and West Virginia for about 94 miles and has a drainage area within the state of 476 square miles. Principal tributaries to the Tug Fork within the state include Rockcastle Creek, Wolf Creek, and Big Creek. Six ambient monitoring stations are located in the basin.

The elevation of the Big Sandy River ranges from 2,400 feet above mean sea level (m.s.l.) at the head of Levisa Fork and 2,200 feet above m.s.l. at the head of Tug Fork to 498 feet above m.s.l. at its confluence with the Ohio River. The average main stem slope of the Big Sandy is 9.9 feet/mile while many of its tributaries have average slopes of over 50 feet/mile.

Steep terrain and shallow soil depths account for the limited agriculture in the basin. Localized silviculture operations occur throughout the drainage. The mainstay of the economy lies in the vast coal reserves underlying the basin. Both surface and deep mining, and to a lesser extent several small petroleum fields, provide jobs for most of the residents.

Impacts

The principal impacts to the streams in Big Sandy River basin are increased siltation and to a lesser extent increased nutrient enrichment. Acid mine drainage is limited to a few localized areas in the upper half of the drainage. The lower 12 miles of the main stem receive at least 5 industrial discharges which impact this section of the stream. Oil and gas drilling have degraded the water quality in the Blaine Creek and Johnson Creek subbasins. Other impacts are road construction, domestic sewage, urban runoff and agriculture.

The aquatic biota has been adversely affected by surface mine runoff over a large portion of the drainage. Essentially every major watershed has been impacted to some degree by surface mining. Water quality perturbations have been so extensive in some localized areas as to virtually eliminate the aquatic fauna. Two fish kills were reported for 1982 and three for 1983 in the Kentucky portion of the drainage.

Problem Parameters

Fecal coliform bacteria was the primary problem water parameter throughout the basin with copper and iron also elevated. High chlordane levels were present in sediments.

Flow

The average discharge for the period of record (56 years) is 2,486 cfs for the Levisa Fork at Paintsville (River Mile Index 65.2). Mean discharge for water year 1982 was below the annual average discharge (~15%). During water year 1983, the mean discharge was 12% below the annual average. The concentration effect of flow reduction during the reporting period was a contributing factor to observed increases in certain physicochemical parameters.

Hydrologic Unit 05070201 - Tug Fork

A total of 288 miles of streams draining 1,559 square miles (476 square miles in Kentucky) comprise this hydrologic unit. The major urban center (in Kentucky) is Inez (pop. 469). Two water quality monitoring stations are located in this hydrologic unit: Tug Fork at Kermit and Tug Fork at state line.

o Dissolved Oxygen (DO) (mg/l)

For the reporting period DO ranged from a minimum of 5.2 to a maximum of 12.3 with a mean range of 8.3 to 8.6 and a median range of 8.4 to 8.5.

o pH

For the reporting period pH ranged from a minimum of 6.7 to a maximum of 8.5 with a mean range of 7.5 to 7.8 and a median range of 7.6 to 7.9. For the period of record (1979-1983) pH ranged from a minimum of 6.7 to a maximum of 8.5 with a mean range of 7.6 to 7.9 and a median range of 7.7 to 7.9.

o Acidity (mg/l)

For the reporting period acidity ranged from a minimum of 1.2 to a maximum of 48.8 with a mean range of 4.8 to 16.0 and a median range of 5.8 to 6.2. For the period of record (1979-1983) acidity ranged from a minimum of 0.0 to a maximum of 48.8 with a mean range of 4.3 to 9.9 and a median range of 4.0 to 4.2.

o Alkalinity (mg/l)

For the reporting period alkalinity ranged from a minimum of 48.8 to a maximum of 269.0 with a mean range of 107.8 to 142.8 and a median range of 107.0 to 120.6. For the period of record (1979-1983) alkalinity ranged from a minimum of 15.6 to a maximum of 269.0 with a mean range of 105.7 to 127.8 and a median range of 106.0 to 113.0.

o Conductivity (µmhos/cm)

For the reporting period conductivity ranged from a minimum of 228.0 to a maximum of 922.0 with a mean range of 482.8 to 495.9 and a median range of 442.0 to 527.0. For the period of record (1979-1983) conductivity ranged from a minimum of 197.0 to a maximum of 923.0 with a mean range of 465.5 to 478.4 and a median range of 432.0 to 433.0.

o Chlorides (mg/l)

For the reporting period chlorides ranged from a minimum of 0.7 to a maximum of 90.0 with a mean range of 10.3 to 19.7 and a median range of 8.8 to 13.1. For the period of record (1979-1983) chlorides ranged from a minimum of 0.7 to a maximum of 90.0 with a mean range of 9.5 to 19.5 and a median range of 8.2 to 12.9.

o Sulfates (mg/l)

For the reporting period sulfates ranged from a minimum of 45.4 to a maximum of 204.0 with a mean range of 100.5 to 108.9 and a median range of 91.8 to 101.0. For the period of record (1979-1983) sulfates ranged from a minimum of 14.8 to a maximum of 220.0 with a mean range of 96.1 to 106.1 and a median range of 88.2 to 96.4.

o NO₂-NO₃-N (mg/l)

For the reporting period NO₂-NO₃-N ranged from a minimum of 0.015 to a maximum of 0.645 with a mean range of 0.260 to 0.354 and a median range of 0.245 to 0.350. For the period of record (1979-1983) NO₂-NO₃-N ranged from a minimum of 0.01 to a maximum of 0.64 with a mean range of 0.27 to 0.34 and a median range of 0.28 to 0.36.

o Total Phosphorus (mg/l)

For the reporting period total phosphorus ranged from a minimum of 0.020 to a maximum of 0.145 with a mean range of 0.053 to 0.075 and a median range of 0.049 to 0.075. For the period of record (1979-1983) total phosphorus ranged from a minimum of 0.015 to a maximum of 0.875 with a mean range of 0.054 to 0.090 and a median range of 0.051 to 0.068.

o Fecal Coliform

Fecal coliform standards were exceeded 65% of the time during the reporting period. The highest percentage of violations occurred at the Tug Fork at Kermit station.

Hydrologic Unit 05070202 - Levisa Fork/Greasy Creek

A total of 234 miles of streams draining 358 square miles (in Kentucky) comprise this hydrologic unit. The major urban center is Jenkins (pop. 3,271). Recreation centers include Fishtrap Lake. There are no water quality monitoring stations located in this unit.

Hydrologic Unit 05070203 - Levisa Fork

A total of 572 miles of streams draining 1,228 square miles comprise this hydrologic unit. Major urban centers include Pikeville (pop. 4,756), Prestonsburg (pop. 4,011), and Paintsville (pop. 3,815). Recreation centers include Dewey Lake and Jenny Wiley State Park. Three water quality monitoring stations are located in this hydrologic unit: Levisa Fork at Pikeville, Levisa Fork at Paintsville, and Paint Creek near the mouth.

o Dissolved Oxygen (DO) (mg/l)

For the reporting period DO ranged from a minimum of 4.0 to a maximum of 14.0 with a mean range of 8.3 to 8.6 and a median range of 8.3 to 8.4.

o pH

For the reporting period pH ranged from a minimum of 6.4 to a maximum of 9.4 with a mean range of 7.1 to 7.5 and a median range of 7.0 to 7.4. For the period of record (1979-1983) pH ranged from a minimum of 6.4 to a maximum of 9.4 with a mean range of 7.3 to 7.5 and a median range of 7.2 to 7.5.

o Acidity (mg/l)

For the reporting period acidity ranged from a minimum of 0.9 to a maximum of 39.0 with a mean range of 7.1 to 8.3 and a median range of 5.0 to 5.6. For the period of record (1979-1983) acidity ranged from a minimum of 0.0 to a maximum of 39.0 with a mean range of 5.8 to 6.0 and a median range of 4.4 to 4.8.

o Alkalinity (mg/l)

For the reporting period alkalinity ranged from a minimum of 25.0 to a maximum of 125.0 with a mean range of 56.8 to 63.6 and a median range of 47.1 to 64.7. For the period of record (1979-1983) alkalinity ranged from a minimum of 17.0 to a maximum of 135.8 with a mean range of 54.1 to 61.1 and a median range of 47.6 to 62.0.

o Conductivity (μ mhos/cm)

For the reporting period conductivity ranged from a minimum of 174.0 to a maximum of 1120.0 with a mean range of 362.2 to 389.2 and a median range of 342.0 to 405.0. For the period of record (1979-1983) conductivity ranged from a minimum of 126.0 to a maximum of 1120.0 with a mean range of 359.3 to 375.9 and a median range of 286.0 to 377.0.

o Chlorides

For the reporting period chlorides ranged from a minimum of 3.9 to a maximum of 278.0 with a mean range of 8.7 to 60.7 and a median range of 8.3 to 37.4. For the period of record (1979-1983) chlorides ranged from a minimum of 2.3 to a maximum of 278.0 with a mean range of 8.7 to 58.0 and a median range of 7.5 to 36.1.

o Sulfates (mg/l)

For the reporting period sulfates ranged from a minimum of 13.0 to a maximum of 202.0 with a mean range of 38.4 to 110.8 and a median range of 33.1 to 113.0. For the period of record (1979-1983) sulfates ranged from a minimum of 7.8 to a maximum of 220.0 with a mean range of 38.4 to 103.4 and a median range of 33.1 to 106.1.

o NO₂-NO₃-N (mg/l)

For the reporting period NO₂-NO₃-N ranged from a minimum of 0.01 to a maximum of 0.73 with a mean range of 0.23 to 0.39 and a median range of 0.20 to 0.38. For the period of record (1979-1983) NO₂-NO₃-N ranged from a minimum of

0.01 to a maximum of 0.73 with a mean range of 0.21 to 0.38 and a median range of 0.20 to 0.38.

o Total Phosphorus (mg/l)

For the reporting period total phosphorus ranged from a minimum of 0.02 to a maximum of 0.66 with a mean range of 0.05 to 0.07 and a median range of 0.04 to 0.05 mg/l. For the period of record (1979-1983) total phosphorus ranged from a minimum of 0.005 to a maximum of 0.66 with a mean range of 0.06 to 0.07 and a median range of 0.04 to 0.05.

o Fecal Coliform

Fecal coliform standards were exceeded 57% of the time during the reporting period. The highest percentage of violations occurred at the Levisa Fork at Paintsville station.

o Biological

The Levisa Fork at Paintsville station was dominated by sparse growths of filamentous green and blue-green algae as well as epipellic diatoms. Periphyton chlorophyll *a* values were average with regard to all BWMP stations although they exhibited large variability among replicate samplers. (Mean = 19.3 mg/m², Range (2.7-46.3)). Values for Ash Free Dry Weight (AFDW) were above average (4.32 g/m², Range (2.06-7.32)). Plankton chlorophyll *a* values were low (1.6 ug/l), most likely limited by turbidity. A total of 105 algal species were identified from natural substrate collections. The diatom community was dominated by epipellic (occurring on sediment) species such as Gyrosigma, Surirella, and certain Nitzschia species.

The invertebrate collections from this station were diverse. The functional groupings expressed considerable speciation. Many kinds of habitats were available to most groups common to lotic (running) waters. The most obvious influences to the benthic community are related to siltation and nutrient enrichment which also affects water quality in the stream.

No Food and Drug Administration (F.D.A.) action levels were exceeded in fish tissue at this station in 1983.

Hydrologic Unit 05070204 - Blaine Creek

A total of 162 miles of streams draining 337 square miles comprise this hydrologic unit. Major urban centers include Louisa (pop. 1,832) and Fallsburg. Three water quality monitoring stations are located in this hydrologic unit: two on the Big Sandy River at Louisa, and one on Blaine Creek at Fallsburg.

o Dissolved Oxygen (DO) (mg/l)

For the reporting period DO ranged from a minimum of 4.4 to a maximum of 13.2 with a mean of 9.3 and a median of 8.8.

o pH

For the reporting period pH ranged from a minimum of 6.5 to a maximum of 8.0 with a mean range of 7.2 to 7.6 and a median range of 7.2 to 7.7. For the period of record (1965-1983) pH ranged from a minimum of 6.5 to a maximum of 8.1 with a mean range of 7.2 to 7.6 and a median range of 7.2 to 7.6.

o Acidity (mg/l)

For the reporting period acidity ranged from a minimum of 1.9 to a maximum of 19.5 with a mean of 5.7 and a median of 4.6. For the period of record (1979-1983) acidity ranged from a minimum of 1.9 to a maximum of 19.5 with a mean of 5.2 and a median of 4.0.

o Alkalinity (mg/l)

For the reporting period alkalinity ranged from a minimum of 8.0 to a maximum of 363.0 with a mean range of 44.0 to 58.0 and a median range of 28.0 to 58.0. For the period of record (1979-1983) alkalinity ranged from a minimum of 0.0 to a maximum of 363.0 with a mean range of 36.0 to 78.0 and a median range of 28.0 to 92.0.

o Conductivity (µmhos/cm)

For the reporting period conductivity ranged from a minimum of 217.0 to a maximum of 4230.0 with a mean range of 390.0 to 943.0 and a median range of 351.0 to 774.0. For the period of record (1965-1983) conductivity ranged from a minimum of 125.0 to a maximum of 4230.0 with a mean range of 371.0 to 986.0 and a median range of 352.0 to 774.0.

o Chlorides (mg/l)

For the reporting period chlorides ranged from a minimum of 6.5 to a maximum of 991.0 with a mean range of 14.9 to 216.4 and a median range of 12.0 to 153.0. For the period of record (1965-1983) chlorides ranged from a minimum of 3.0 to a maximum of 991.0 with a mean range of 15.3 to 241.9 and a median range of 12.0 to 160.0.

o Sulfates (mg/l)

For the reporting period sulfates ranged from a minimum of 8.4 to a maximum of 44.4 with a mean of 28.5 and a median of 31.4. For the period of record (1979-1983) sulfates ranged from a minimum of 7.8 to a maximum of 44.8 with a mean of 28.0 and a median of 30.2.

o NO₂-NO₃-N (mg/l)

For the reporting period NO₂-NO₃-N ranged from a minimum of 0.015 to a maximum of 0.655 with a mean of 0.32 and a median of 0.34. For the period of record (1979-1983) NO₂-NO₃-N ranged from a minimum of 0.015 to a maximum of 0.655 with a mean of 0.314 and a median range of 0.290.

o Total phosphorus

For the reporting period total phosphorus ranged from a minimum of 0.004 to a maximum of 0.45 with a mean of 0.045 and a median of 0.022. For the period of record (1979-1983) total phosphorus ranged from a minimum of 0.004 to a maximum of 0.45 with a mean of 0.039 and a median of 0.025.

o Fecal Coliform

Fecal coliform standards were exceeded 36% of the time during the reporting period.

o Biological

The Blaine Creek station was dominated by moderate growths of filamentous green, blue-green, and red algae, as well as pennate diatoms. Periphyton chlorophyll a values were below average (14.1 mg/m²-Range (9.9-18.9)) as were AFDW values (2.84 g/m²-Range (2.41-3.41)). Plankton chlorophyll a values were typical of small streams (5.1 ug/l). A total of 181 algal species were identified from natural substrate collections. The diatom community was dominated by halophilic, eutrophic, and epipelagic taxa, although many typical Eastern Kentucky stream species were also present.

The invertebrate collections from this station show definite signs of stress from degraded water quality. In spite of ample variety of habitats available to the benthic organisms, the collections reflected a paucity of functional types and species diversity. The organisms collected from this location are considered to be tolerant of many environmental conditions.

No F.D.A. action levels were exceeded in fish tissue at this station in 1983.

LITTLE SANDY RIVER BASIN

The Little Sandy River basin is located in the northeastern portion of the state, lying within the Unglaciaded Appalachian Plateau. The area is underlain with Pennsylvanian age sandstone deposits. The river arises near Sandy Hook, Kentucky, and flows 87 miles to its confluence with the Ohio River at Greenup, Kentucky (Ohio River mile 336.4). Principal tributaries to the Little Sandy include the Little Fork, East Fork and Big Sinking creek. The major impoundment of this area is Grayson Lake near Grayson, Kentucky. There are 360 miles of streams in the basin depicted on the USGS hydrologic unit maps, draining an area of 721 square miles.

The topography in the headwater section is generally rugged, with no flat or undulating land present. Closer to the mouth, the terrain becomes less rugged with more bottomland available for agricultural practices. Elevations range from 1,300 feet above mean sea level (m.s.l.) in the headwater region near Sandy Hook to 479 feet above m.s.l. at the river's confluence with the Ohio. Average slope for the Little Sandy is 8.3 feet/mile.

Impacts

The major impact in the Little Sandy River basin is coal mining, which contributes increased sediment loads to the receiving streams. Domestic sewage and agricultural runoff are minor impacts. Siltation resulting from coal mining operations has adversely affected the aquatic biota in the Little Sandy basin. No fish kills were reported in 1982 or 1983.

Flow

The annual average discharge for the period of record (45 years) is 475 cfs for Little Sandy at Grayson (RMI 38.05). Mean discharge for water year 1982 was below the annual average discharge (-24%). However, during water year 1983, mean discharge was only 6% below the annual average.

Hydrologic Unit 05090104 - Little Sandy River

This hydrologic unit composes the entire Little Sandy River basin. There are no water quality monitoring stations located in this unit.

TYGARTS CREEK BASIN

The Tygarts Creek basin is located in the northeastern portion of the state, lying within the Unglaciaded Allegheny Plateau region of the Appalachian Plateaus Province. The bedrock in the headwaters is Pennsylvanian sandstone but as the stream flows northward it cuts into Mississippian limestone deposits. Tygarts Creek originates in southwestern Carter County, Kentucky and flows in a northeasterly direction for its 89.3 miles, where it empties into the Ohio River at South Shore, Kentucky (mile point 353.2). The principal tributary is Buffalo Creek with a drainage area of 54 square miles. The entire basin has a drainage area of 339 square miles. There are 194 stream miles in the basin depicted on the USGS hydrologic unit map.

The topography for the watershed varies from steep hillsides and narrow valleys in the headwaters to broad, wide valleys near the mouth. Elevations range from 485 feet above mean sea level (m.s.l.) at its confluence with the Ohio River to 1300 feet above m.s.l. at the source. The average slope of Tygarts Creek is 6.9 feet/mile. The average stream channel width ranges from about 30 feet in the headwater reaches to over 200 feet near the mouth.

Impacts

Municipal sewage from the city of Olive Hill is the main impact on Tygarts Creek, with some minor impacts from mining and oil drilling operations.

Tygarts Creek supports a diverse assemblage of aquatic organisms throughout the drainage. No fish kills occurred during the reporting period. There are no water quality monitoring stations located in this basin.

Flow

The annual average discharge for the period of record (26 years) is 85.9 cfs for Tygarts Creek at Olive Hill (RMI 78.0). Mean discharge for water year 1982 was below the annual average discharge (-38%). During water year 1983, mean discharge was 12% below the annual average.

Hydrologic Unit 05090103 - Tygarts Creek

Hydrologic unit 05090103 contains 194 stream miles which encompasses the entire Tygarts Creek basin. With the exception of 6.1 mi of Shultz Creek, the entire stream system has been recommended to be classified for Aquatic Life/Warmwater Aquatic Habitat use. Shultz Creek supports a "put and take" trout fishery, therefore it has been recommended for Aquatic Life/Coldwater Aquatic Habitat use. Also, the entire drainage has been recommended for Primary and Secondary Contact Recreation use. The Olive Hill Reservoir and Tygarts Creek at mile point 78.89 are recommended for Domestic Water Supply use. Stream use designation work indicated that Kentucky Surface Water Standards (KSWS) for aluminum, mercury, iron and undissociated hydrogen sulfide were violated. Historical data indicate the KSWS for pH and alkalinity were violated in a small headwater, coal mining impacted stream, which does not appear on the hydrologic unit map. The Tygarts Creek basin supports an excellent diversity of aquatic habitats and aquatic fauna. Therefore, with the exception of a two mile stream reach impacted by the Olive Hill wastewater treatment plant, the recommended stream uses are supported. This two mile reach at Olive Hill partially supports the recommended use.

LICKING RIVER BASIN

The Licking River basin is located within the eastern portion of Kentucky in two major physiographic provinces, the Allegheny Plateaus and Interior Low Plateaus. It rises in southeastern Kentucky and flows northwesterly to the confluence with the Ohio River in the Covington-Newport, Kentucky area at an elevation of 420 feet above mean sea level (m.s.l.). There are 2,034 miles of streams in the basin depicted on the USGS hydrologic unit map. Three ambient monitoring stations are located in the basin. The total drainage area is 3,700 square miles. Principal tributaries are the North Fork and South Fork of the Licking. The major impoundment of this area is Cave Run Lake near Farmers, Kentucky.

The topography of the headwaters area is characteristic of the unglaciated region of the Appalachian Plateaus. This area is dissected into narrow ridges and steep sided valleys by a network of streams. The underlying rocks are Pennsylvanian Age sandstone. Maximum elevation in the headwaters is 1,000 feet above m.s.l. Average slope for the Licking River main stem is 2.26 feet/mile.

Upon leaving the Appalachian Plateaus, the Licking flows through sections of the Interior Low Plateaus known as the Knobs and the Blue Grass. The Knobs are characterized by conical and flat-topped hills with broad valleys. The Blue grass topography ranges from an area of gently rolling hills adjacent to the Knobs, to an area highly dissected by a network of streams which have formed V-shaped valleys and narrow ridges. Mississippian and Ordovician limestones underlie most of this section.

Impacts

In the upper portion of the drainage, coal mining and gas and oil drilling operations are the major impacts. These operations contribute increased silt loads and brines to the streams. In the lower river, agricultural runoff and domestic sewage increase nutrient levels. The last few miles drain a heavily industrialized area.

The aquatic biota above Cave Run Reservoir has been impacted by coal mining and oil and gas operations; however, below the reservoir the river supports a diverse and complex group of organisms. The stability of biotic communities below the reservoir may change as oil and gas drilling increase in the drainage. Four fish kills were reported in the drainage for 1982, five occurred in 1983.

Problem Parameters

Total phosphorus was elevated throughout the basin, while fecal coliform bacteria and nitrite and nitrate-nitrogen were elevated at scattered locations. Copper was above average in the water and chlordane levels were high in sediments.

Flow

The annual average discharge for the period of record (57 years) is 4,143 cfs for the Licking River at mile point 48.0. Mean discharge for water year 1982 was below the annual average discharge (-22%). During water year 1983, mean discharge was 7% below the annual average. The concentration effect of flow reduction during the reporting period was a contributing factor to observed increases in certain physicochemical parameters.

Hydrologic Unit 051001001 - Licking River

A total of 1,439 miles of streams draining 2,780 square miles comprise this hydrologic unit. Major urban centers include Covington (pop. 49,563), Morehead (pop. 7,789), Salyersville (pop. 1,352), and West Liberty (pop. 1,381). Recreation centers include Cave Run Lake, Blue Lick State Park, Kincaid Lake, and Lake Carnico. Four water quality monitoring stations are located in this hydrologic unit: Licking River at Sherburne, North Fork Licking River near Lewisburg, Licking River at Covington, and Licking River at Butler.

Thirty nine miles (Fleming Creek drainage) of this unit have been recommended for Aquatic Life/Warmwater Aquatic Habitat and Primary and Secondary Contact Recreation uses. In addition, it has been recommended that the Fleming Creek reservoir be designated for domestic water supply use. A stream use designation study revealed a violation of Kentucky Surface Water Standards for phthalate esters, mercury and aluminum. The Fleming Creek basin is considered to support the recommended use designation because of its diverse aquatic habitat and fauna and its generally good water quality.

o Dissolved Oxygen (DO) (mg/l)

For the reporting period DO ranged from a minimum of 4.6 to a maximum of 14.1 with a mean of 9.9 and a median of 9.8.

o pH

For the reporting period pH ranged from a minimum of 6.9 to a maximum of 8.2 with a mean range of 7.3 to 7.7 and a median range of 7.2 to 7.6. For the period of record (1979-1983) pH ranged from a minimum of 6.9 to a maximum of 8.3 with a mean range of 7.3 to 7.8 and a median range of 7.4 to 7.8.

o Acidity (mg/l)

For the reporting period acidity ranged from a minimum of 2.0 to a maximum of 29.0 with a mean of 10.1 and a median of 7.7. For the period of record (1979-1983) acidity ranged from a minimum of 0.0 to a maximum of 29.0 with a mean of 8.0 and a median of 7.4.

o Alkalinity (mg/l)

For the reporting period alkalinity ranged from a minimum of 39.8 to a maximum of 180.0 with a mean range of 106.0 to 128.7 and a median range of 106.0 to 138.0. For the period of record (1974-1983) alkalinity ranged from a minimum of 0.0 to a maximum of 158.0 with a mean range of 8.0 to 122.6 and a median range of 7.4 to 110.0.

o Conductivity (µmhos/cm)

For the reporting period conductivity ranged from a minimum of 156.0 to a maximum of 445.0 with a mean range of 197.8 to 349.5 and a median range of 178.0 to 354.0. For the period of record (1974-1983) conductivity ranged from a minimum of 156.0 to a maximum of 503.0 with a mean range of 202.5 to 355.7 and a median range of 195.0 to 353.0.

o Chlorides (mg/l)

For the reporting period chlorides ranged from a minimum of 2.9 to a maximum of 16.0 with a mean range of 7.9 to 12.1 mg/l and a median range of 8.0 to 11.0. For the period of record (1974-1983) chlorides ranged from a minimum of 0.9 to a maximum of 18.1 with a mean range of 5.98 to 10.4 and a median range of 5.7 to 10.0.

o Sulfates (mg/l)

For the reporting period sulfates ranged from a minimum of 16.8 to a maximum of 65.2 with a mean of 35.3 and a median of 35.0. For the period of record (1979-1983) sulfates ranged from a minimum of 16.8 to a maximum of 65.2 with a mean of 36.3 and a median of 35.2.

o NO₂-NO₃-N (mg/l)

For the reporting period NO₂-NO₃-N ranged from a minimum of 0.02 to a maximum of 4.05 with a mean range of 0.74 to 1.22 and a median range of 0.65 to 0.87. For the period of record (1974-1983) NO₂-NO₃-N ranged from a minimum of 0.01 to a maximum of 4.05 with a mean range of 0.63 to 0.99 and a median range of 0.54 to 0.72.

o Total Phosphorus (mg/l)

For the reporting period total phosphorus ranged from a minimum of 0.019 to a maximum of 1.79 with a mean range of 0.039 to 0.22 and a median range of 0.03 to 0.15. For the period of record (1974-1983) total phosphorus ranged from a minimum of 0.019 to a maximum of 3.3 with a mean range of 0.10 to 0.27 and a median range of 0.05 to 0.17.

o Fecal Coliform

Fecal coliform standards were exceeded 37% of the time during the reporting period.

o Biological

The North Fork Licking River station was characterized by moderate to dense growths of filamentous blue-green, green, and red algae. Pennate diatoms were speciose. The centric diatom, Skeletonema potanos dominated plankton collections. Periphyton chlorophyll a values were above average (30.2 mg/m², Range 15.1-47.1) while AFDW was below average (2.75 g/m², Range 2.23-3.21). Plankton chlorophyll a was below average (9.8 ug/l). A total of 161 algal species were identified from natural substrate collections. Planktonic green and euglenoid algae were common, suggesting nutrient enrichment, most likely from agricultural activities. The diatom community was dominated by typical stream species, as well as those associated with nutrient enrichment. The North Fork Licking River appears to be a productive stream with good water quality.

The Licking River at Sherburne station was characterized by moderate growths of filamentous green, blue-green, and red algae. Pennate diatoms were speciose. Periphyton chlorophyll *a* values were below average (8.3 mg/m², Range 5.4-10.8) as were AFDW values (1.70 g/m², Range 1.38-1.97). Plankton chlorophyll *a* values were below average (9.3 ug/l). A total of 165 algal species were identified from natural substrate collections. The diatom community was dominated by typical stream species. The Licking River appears to be a productive stream with good water quality.

The invertebrates collected from the North Fork Licking River station were diverse in relation to available habitats. Most members of the community are typical of small unimpacted streams of that area. There are no obvious alterations in the benthic community from degraded water quality. Siltation and nutrient enrichments are not detectable. The water quality at this location in relation to the benthic community is exceptional.

The invertebrates collected at the Licking River at Sherburne station were typical for the habitats and stream size. Most functional groupings were well represented. Species composition reflected ample partitioning of available habitats. The community did not reflect any obvious influences from water quality factors. Although nutrient enrichment from agricultural practices was predictable, it was not evident through the benthic community structure. The stream appears to support a diverse benthic fauna and contain good water quality.

No F.D.A. action levels were exceeded in fish tissue at these stations in 1982 or 1983.

Hydrologic Unit 05100102 - South Fork Licking River

A total of 595 miles of streams draining 927 square miles comprise this hydrologic unit. Major urban centers include Paris (pop. 7,935), Cynthiana (pop. 5,881), and Falmouth (pop. 2,482). One water quality monitoring station is located in this hydrologic unit: South Fork Licking River at Cynthiana.

o pH

For the reporting period pH ranged from a minimum of 7.4 to a maximum of 8.3 with a mean of 7.9 and a median of 7.9. For the period of record (1956-1983) pH ranged from a minimum of 7.4 to a maximum of 8.3 with a mean of 7.9 and a median of 7.9.

o Alkalinity (mg/l)

For the reporting period alkalinity was not measured. For the period of record (1962-1972) alkalinity ranged from a minimum of 95.0 to a maximum of 164.0 with a mean of 131.7 and a median of 120.0.

o Conductivity (μmhos/cm)

For the reporting period conductivity ranged from a minimum of 275.0 to a maximum of 920.0 with a mean of 498.0 and a median of 415.0. For the period of record (1956-1983) conductivity ranged from a minimum of 117.0 to a maximum of 920.0 with a mean of 402.7 and a median of 390.0.

o Chlorides (mg/l)

For the reporting period chlorides ranged from a minimum of 4.1 to a maximum of 120.0 with a mean of 20.5 and a median of 9.1. For the period of record (1956-1983) chlorides ranged from a minimum of 2.9 to a maximum of 120.0 with a mean of 18.2 and a median of 9.6.

o Total Phosphorus (mg/l)

For the reporting period total phosphorus ranged from a minimum of 0.05 to a maximum of 4.1 with a mean of 0.59 and a median of 0.32. For the period of record (1982-1983) total phosphorus ranged from a minimum of 0.05 to a maximum of 4.1 with a mean of 0.59 and a median of 0.32.

KENTUCKY RIVER BASIN

The Kentucky River basin drains 7,033 square miles in the Cumberland Plateau and Blue Grass sections. The main stem of the Kentucky River is formed by the confluence of the North Fork, Middle Fork, and South Fork in the Beattyville, Kentucky area. Flowing northwesterly 255 miles, the river joins the Ohio River at Carrollton, Kentucky (Ohio River mile 435.6). A series of 14 U. S. Army Corps of Engineers Locks and Dams impound the river from the mouth to Beattyville. There are 3,899 miles of streams in the basin depicted on the USGS hydrologic unit map. The total drainage area is 6,966 square miles. Principal tributaries to the Kentucky River are the Red River, Dix River, Elkhorn and Eagle Creeks. Major impoundments of this basin are Herrington, Buckhorn and Carr Fork lakes.

Watershed topography varies considerably. The upper third of the drainage lies on Pennsylvanian sandstone in the Cumberland Plateau. This area is characterized by deeply dissected valleys, narrow ridge tops, and steep slopes. Average slope of the tributaries in that section ranges from 3 feet/mile to 7.2 feet/mile with the main stem averaging 0.9 feet/mile. The highest elevation in the basin is Pine Mountain, 2,273 feet above mean sea level (m.s.l.).

Adjacent to the mountainous area is the Interior Low Plateaus in which the Blue Grass and Knobs sections lie. These plateaus are underlain by limestones of the Ordovician, Devonian and Silurian periods. The Knobs form a narrow crescent separating the Blue Grass from the Cumberland Plateau and are characterized by hills with steep slopes. Topography of the Blue Grass varies from gently rolling terrain, to areas highly dissected by dendritic drainage systems with V-shaped valleys and narrow ridges, to broad undulating peneplains marked by karst areas. Average slope of the tributaries in the Blue Grass ranges from 3 feet/mile to 32 feet/mile. The main stem of the Kentucky averages 0.7 feet/mile. Maximum elevation in the Blue Grass approaches 1,000 feet above m.s.l.

Impacts

The main impacts to the Kentucky River drainage are mining and agricultural practices. Demand for fossil fuels in the past decade has greatly increased surface mining within the basin, causing a further increase in siltation of downstream areas. Cultivation of the narrow floodplains in the highlands and intensive farming throughout the Knobs and Blue Grass sections contribute to nutrient and sediment loading of the drainage.

Numerous municipal wastewater treatment plant discharges affect the water quality of the streams in the basin, primarily by nutrient enrichment and oxygen depletion.

Improper oil and gas drilling operations have recently become a serious water quality problem in portions of the drainage. The South Fork of the Red River has been extensively impacted by these operations, resulting in localized elimination of the aquatic fauna. Perturbations are so severe that they have adversely affected public water supplies as far downstream on the Kentucky River as Lexington.

The aquatic biota is generally good throughout most of the basin except in some coal field tributaries that have been impacted by mining or oil drilling. Some Blue Grass streams have been impacted by municipal wastewater treatment plant effluents. There were eight fish kills reported in 1982 and 13 in 1983.

Problem Parameters

Fecal coliform bacteria, nutrients (total phosphorus and nitrite and nitrate-nitrogen) and copper were problem water parameters. Chlordane was elevated in sediments throughout the basin.

Flow

The annual average discharge for the period of record (58 years) is 309 cfs for the Kentucky River at mile point 31.0. Mean discharge for water year 1982 was slightly below the annual average discharge (-20%). During water year 1983, mean discharge was 10% below annual average. The concentration effect of flow reduction during the reporting period was a contributing factor to the observed increases in certain physiochemical parameters.

Biological

Biological collections from the mainstem of the Kentucky began in 1979. The 1983 collections included stations above and below Frankfort, which represents the farthest downstream sampling stations to date.

In past years, the biological collections have indicated the benthic communities to be diverse in structure and composition for the available habitats. The water quality factors that consistently affect those communities are siltation and nutrient enrichments. The 1983 biological collections indicate some improvements in the benthic community structures and species composition.

In spite of siltation and nutrient enrichment to the system, the main stem water quality is considered good.

Hydrologic Unit 05100201 - North Fork Kentucky River

A total of 877 miles of streams draining 1319 square miles comprise this hydrologic unit. Major urban centers include Jackson (pop. 2,651), and Hazard (pop. 5,371). Recreation centers include Carr Fork Lake, Fishpond Lake, and Pan Bowl Lake. One water quality monitoring station is located in this hydrologic unit: North Fork Kentucky River at Jackson.

o pH

For the reporting period pH ranged from a minimum of 7.4 to a maximum of 8.1 with a mean of 7.7 and a median of 7.7. For the period of record (1980-1983) pH ranged from a minimum of 7.0 to a maximum of 8.1 with a mean of 7.6 and a median of 7.7.

o Alkalinity (mg/l)

For the reporting period alkalinity was not measured. For the period of record (1970-1983) alkalinity ranged from a minimum of 24.0 to a maximum of 84.0 with a mean of 55.0 and a median of 53.0.

o Conductivity ($\mu\text{mhos/cm}$)

For the reporting period conductivity ranged from a minimum of 254.0 to a maximum of 782.0 with a mean of 450.0 and a median of 420.0. For the period of record (1970-1983) conductivity ranged from a minimum of 130.0 to a maximum of 782.0 with a mean of 404.0 and a median of 400.0.

o Chlorides (mg/l)

For the reporting period chlorides ranged from a minimum of 3.1 to a maximum of 13.0 with a mean of 6.8 and a median of 6.1. For the period of record (1970-1983) chlorides ranged from a minimum of 3.1 to a maximum of 13.0 with a mean of 7.0 and a median of 6.8.

o Total Phosphorus (mg/l)

For the reporting period total phosphorus ranged from a minimum of 0.01 to a maximum of 2.0 with a mean of 0.22 and a median of 0.07. For the period of record (1972-1983) total phosphorus ranged from a minimum of 0.01 to a maximum of 2.0 with a mean of 0.16 and a median of 0.03.

Hydrologic Unit 05100202 - Middle Fork Kentucky River

A total of 228 miles of streams draining 559 square miles comprise this hydrologic unit. The major urban center is Hyden (pop. 488). Recreation centers include Buckhorn Lake. One water quality monitoring station is located in this hydrologic unit: Middle Fork Kentucky River at Tallega.

o pH

For the reporting period pH ranged from a minimum of 6.5 to a maximum of 8.0 with a mean of 7.4 and a median of 7.4. For the period of record (1970-1983) pH ranged from a minimum of 6.5 to a maximum of 8.0 with a mean of 7.4 and a median of 7.4.

o Alkalinity (mg/l)

For the reporting period alkalinity was not measured. For the period of record (1970-1983) alkalinity ranged from a minimum of 15.0 to a maximum of 58.0 with a mean of 33.6 and a median of 30.0.

o Conductivity ($\mu\text{mhos/cm}$)

For the reporting period conductivity ranged from a minimum of 120.0 to a maximum of 259.0 with a mean of 195.0 and a median of 188.0. For the period of record (1970-1983) conductivity ranged from a minimum of 100.0 to a maximum of 400.0 with a mean of 187.9 and a median of 179.0.

o Chlorides (mg/l)

For the reporting period chlorides ranged from a minimum of 1.8 to a maximum of 7.7 with a mean of 5.1 and a median of 5.0. For the period of record (1970-1983) chlorides ranged from a minimum of 1.8 to a maximum of 7.7 with a mean of 5.2 and a median of 5.1.

o Total Phosphorus (mg/l)

For the reporting period total phosphorus ranged from a minimum of 0.01 to a maximum of 1.3 with a mean of 0.12 and a median of 0.025. For the period of record (1972-1983) total phosphorus ranged from a minimum of 0.01 to a maximum of 1.3 with a mean of 0.097 and a median of 0.030.

Hydrologic Unit 05100203 - South Fork Kentucky River

A total of 332 miles of streams draining 748 square miles comprise this hydrologic unit. Major urban centers include Manchester (pop. 1,838) and Booneville (pop. 191). Recreation centers include Bert Combs Lake. One water quality monitoring station is located in this hydrologic unit: South Fork Kentucky River at Booneville.

o pH

For the reporting period pH ranged from a minimum of 7.0 to a maximum of 7.6 with a mean of 7.3 and a median of 7.4. For the period of record (1980-1983) pH ranged from a minimum of 7.0 to a maximum of 8.0 with a mean of 7.35 and a median of 7.3.

o Alkalinity (mg/l)

For the reporting period alkalinity was not measured. For the period of record (1966-1983) alkalinity ranged from a minimum of 16.0 to a maximum of 60.0 with a mean of 34.3 and a median of 31.0.

o Conductivity (μ mhos/cm)

For the reporting period conductivity ranged from a minimum of 139.0 to a maximum of 548.0 with a mean of 258.0 and a median of 205.0. For the period of record (1965-1983) conductivity ranged from a minimum of 76.0 to a maximum of 548.0 with a mean of 226.0 and a median of 200.0.

o Chlorides (mg/l)

For the reporting period chlorides ranged from a minimum of 0.6 to a maximum of 45.0 with a mean of 14.2 and a median of 8.2. For the period of record (1965-1983) chlorides ranged from a minimum of 0.6 to a maximum of 45.0 with a mean of 13.7 and a median of 8.3.

o Total Phosphorus (mg/l)

For the reporting period total phosphorus ranged from a minimum of 0.01 to a maximum of 0.32 with a mean of 0.063 and a median of 0.025. For the period of record (1971-1983) total phosphorus ranged from a minimum of 0.01 to a maximum of 0.32 with a mean of 0.069 and a median of 0.030.

Hydrologic Unit 05100204 - Kentucky River from South Fork to Red River

A total of 592 miles of streams draining 1,093 square miles located in this hydrologic unit. Major urban centers include Irvine (pop. 2,889), Stanton (pop. 2,691), and Clay City (pop. 1,276). Recreation centers include Red River Gorge and Natural Bridge State Park. Two water quality monitoring stations are located in this hydrologic unit: Kentucky River at Heidelberg and Red River at Hazel Green.

o Dissolved Oxygen (DO) (mg/l)

For the reporting period DO ranged from a minimum of 5.9 to a maximum of 13.4 with a mean of 9.9 and a median of 10.1.

o pH

For the reporting period pH ranged from a minimum of 6.6 to a maximum of 8.1 with a mean range of 7.1 to 7.4 and a median range of 7.2 to 7.4. For the period of record (1979-1983) pH ranged from a minimum of 6.5 to a maximum of 8.9 with a mean range of 7.2 to 7.4 and a median range of 7.1 to 7.4.

o Acidity (mg/l)

For the reporting period acidity ranged from a minimum of 1.2 to a maximum of 11.0 with a mean range of 4.5 to 5.4 and a median range of 4.1 to 4.8. For the period of record (1979-1983) acidity ranged from a minimum of 0.0 to a maximum of 11.0 with a mean range of 3.7 to 4.8 and a median range of 3.6 to 4.1.

o Alkalinity (mg/l)

For the reporting period alkalinity ranged from a minimum of 10.0 to a maximum of 80.8 with a mean range of 32.9 to 47.4 and a median range of 31.6 to 48.2. For the period of record (1979-1983) alkalinity ranged from a minimum of 10.0 to a maximum of 80.8 with a mean range of 31.1 to 44.9 and a median range of 26.0 to 43.0.

o Conductivity (µmhos/cm)

For the reporting period conductivity ranged from a minimum of 66.0 to a maximum of 503.0 with a mean range of 111.0 to 290.0 and a median range of 108.0 to 288.0. For the period of record (1979-1983) conductivity ranged from a minimum of 56.0 to a maximum of 737.0 with a mean range of 106.5 to 271.0 and a median range of 96.0 to 268.0.

o Chlorides (mg/l)

For the reporting period chlorides ranged from a minimum of 1.3 to a maximum of 19.2 with a mean range of 4.9 to 8.9 and a median range of 5.1 to 8.2. For the period of record (1979-1983) chlorides ranged from a minimum of 0.6 to a maximum of 19.2 with a mean range of 4.3 to 8.2 and a median range of 3.9 to 7.4.

o Sulfates (mg/l)

For the reporting period sulfates ranged from a minimum of 11.3 to a maximum of 148.0 with a mean range of 15.9 to 74.9 and a median range of 15.0 to 68.9. For the period of record (1979-1983) sulfates ranged from a minimum of 10.0 to a maximum of 148.0 with a mean range of 17.0 to 68.5 and a median range of 14.8 to 64.7.

o NO₂-NO₃-N (mg/l)

For the reporting period NO₂-NO₃-N ranged from a minimum of 0.01 to a maximum of 0.96 with a mean range of 0.32 to 0.34 and a median range of 0.27 to 0.32. For the period of record (1979-1983) NO₂-NO₃-N ranged from a minimum of 0.01 to a maximum of 0.96 with a mean of 0.31 and a median of 0.31.

o Total Phosphorus (mg/l)

For the reporting period total phosphorus ranged from a minimum of 0.008 to a maximum of 0.204 with a mean range of 0.034 to 0.047 and a median range of 0.026 to 0.030. For the period of record (1979-1983) total phosphorus ranged from a minimum of 0.005 to a maximum of 0.564 with a mean range of 0.046 to 0.067 and a median range of 0.029 to 0.035.

o Fecal Coliform

Fecal coliform standards were exceeded 25% of the time during the reporting period. The highest percentage of violations occurred at the Kentucky River at Heidelberg station.

Hydrologic Unit 05100205 - Lower Kentucky River

A total of 1,870 miles of streams draining 3,242 square miles comprise this hydrologic unit. Major urban centers include Lexington (pop. 204,165), Frankfort (pop. 25,973), Richmond (pop. 21,705), and Danville (pop. 12,942). Recreation centers include Herrington Lake and Boonesboro State Park. Five water quality monitoring stations are located in this hydrologic unit: Kentucky River at Camp Nelson, Kentucky River above Frankfort, Kentucky River below Frankfort, Eagle Creek at Glencoe, and South Elkhorn Creek at Weisenberger Mill Pool.

A total of 141 miles have been recommended for stream use designation. The South Elkhorn Creek system encompasses approximately 88 stream miles that have been recommended for Aquatic Life/Warmwater Aquatic Habitat and Primary and Secondary Contact Recreation uses. However, 60 miles of this system has impaired water quality, partially supporting designated uses (35 miles) and not supporting designated uses (25 miles). During a one time stream use designation sampling program, violations of Kentucky Surface Water Standards were observed for dissolved oxygen, un-ionized ammonia, total aluminum, total mercury, phthalate esters, and fecal coliform bacteria. In addition elevated levels for cadmium, nitrite + nitrate - nitrogen and total phosphorus were noted.

The Silver Creek basin has 53 miles of streams that have been recommended for Aquatic Life/Warmwater Aquatic Habitat and Primary and Secondary Contact Recreation use designations. Also, two points on small tributary streams have been recommended for domestic water supply use. Violations for Kentucky Surface Water Standards were observed during stream use designation sampling for undissociated hydrogen sulfide, phthalate esters, aluminum, mercury, and fecal coliform bacteria. With the exception of the area around the Berea wastewater treatment plant (5 miles, partial support), the Silver Creek basin is considered to support the recommended designated uses.

o Dissolved Oxygen (DO) (mg/l)

For the reporting period DO ranged from a minimum of 3.4 to a maximum of 18.0 with a mean range of 10.2 to 10.6 and a median range of 10.2 to 10.8.

o pH

For the reporting period pH ranged from a minimum of 6.8 to a maximum of 8.5 with a mean range of 7.4 to 7.6 and a median range of 7.4 to 7.7. For the period of record (1979-1983) pH ranged from a minimum of 6.8 to a maximum of 8.5 with a mean range of 7.5 to 7.8 and a median range of 7.5 to 7.8.

o Acidity (mg/l)

For the reporting period acidity ranged from a minimum of 0.0 to a maximum of 33.8 with a mean range of 5.9 to 10.9 and a median range of 5.0 to 8.2. For the period of record (1979-1983) acidity ranged from a minimum of 0.0 to a maximum of 33.8 with a mean range of 5.3 to 21.0 and a median range of 4.2 to 6.4.

o Alkalinity (mg/l)

For the reporting period alkalinity ranged from a minimum of 43.7 to a maximum of 208.0 with a mean range of 63.2 to 147.8 and a median range of 66.2 to 150.0. For the period of record (1979-1983) alkalinity ranged from a minimum of 8.4 to a maximum of 262.0 with a mean range of 67.9 to 151.1 and a median range of 69.4 to 150.0.

o Conductivity (μ mhos/cm)

For the reporting period conductivity ranged from a minimum of 185.0 to a maximum of 830.0 with a mean range of 304.4 to 592.1 and a median range of 283.0 to 570.0. For the period of record (1979-1983) conductivity ranged from a minimum of 172.0 to a maximum of 830.0 with a mean range of 301.4 to 403.5 and a median range of 292.0 to 385.0.

o Chlorides (mg/l)

For the reporting period chlorides ranged from a minimum of 3.3 to a maximum of 79.0 with a mean range of 9.8 to 42.0 and a median range of 7.5 to 36.0. For the period of record (1979-1983) chlorides ranged from a minimum of 1.6 to a maximum of 79.0 with a mean range of 8.4 to 20.5 and a median range of 7.4 to 16.9.

o Sulfates (mg/l)

For the reporting period sulfates ranged from a minimum of 24.9 to a maximum of 95.2 with a mean range of 46.9 to 57.8 and a median range of 42.0 to 47.0. For the period of record (1979-1983) sulfates ranged from a minimum of 20.5 to a maximum of 180.0 with a mean range of 43.1 to 58.1 and a median range of 39.0 to 48.2.

o NO₂-NO₃-N (mg/l)

For the reporting period NO₂-NO₃-N ranged from a minimum of 0.01 to a maximum of 3.55 with a mean range of 0.49 to 0.95 and a median range of 0.49 to 0.80. For the period of record (1979-1983) NO₂-NO₃-N ranged from a minimum of 0.005 to a maximum of 3.55 with a mean range of 0.428 to 0.766 and a median range of 0.27 to 0.67.

o Total Phosphorus (mg/l)

For the reporting period total phosphorus ranged from a minimum of 0.014 to a maximum of 3.9 with a mean range of 0.101 to 1.76 and a median range of 0.067 to 1.4. For the period of record (1979-1983) total phosphorus ranged from a minimum of 0.014 to a maximum of 0.69 with a mean range of 0.106 to 0.137 and a median range of 0.088 to 0.133.

o Fecal Coliform

Fecal coliform standards were exceeded 18% of the time during the reporting period. The highest percentage of violations occurred at the Kentucky River above Frankfort station.

o Biological

The Kentucky River above Frankfort station was characterized by moderate to dense growths of filamentous green and blue-green algae, as well as centric and pennate diatoms. Periphyton chlorophyll a values were below average (11.1 mg/m², Range 7.0-16.6) while AFDW values were average (3.87 g/m², Range 2.38-5.21). Plankton chlorophyll a values were below average (7.0 ug/l). A total of 125 algal species were identified from natural substrate collections. The plankton diatom community was dominated by centric diatoms characteristic of eutrophic reservoirs while the benthic diatom community consisted of pennate diatoms associated with nutrient enrichment as well as typical stream taxa.

The Kentucky River below Frankfort station was very similar to the upstream site. The algal community was characterized by moderate to dense growths of filamentous green and blue-green algae, as well as centric and pennate diatoms. Periphyton chlorophyll a values were below average (10.0 mg/m², Range (4.9-17.2)) while AFDW values were slightly above average (4.25 g/m², Range (3.00-5.59)). Plankton chlorophyll a values were above average (42.3 ug/l). The elevated plankton value may be attributable to the influence of the Frankfort WWTP, located approximately 10 miles upstream. A total of 104 algal species were identified from natural substrate collections. Diatom community structure was similar to the upstream site.

The invertebrate collections from the Kentucky River below Frankfort station were very similar to the upstream site. Species composition and functional groupings were practically identical except for a rare caddisfly, *Orotrichia*, which was also collected from the Heidelberg site (PRI 026) in previous years. The influences of nutrients, organic wastes and siltation in this stream system are difficult to detect, because the invertebrate collections contained only the functional types associated with the kinds of habitats that are present. Partitioning of those habitats is maximal which indicates water quality does not adversely affect the benthic communities occurring there. It is the lack of habitats that limits the diversity of organisms in this stream system.

The invertebrates collected from the Kentucky River above Frankfort station represented a 2 year period. The collections in both years were dominated by the caddisfly, *Cyrnellus fraternus*, an organism quite common to large rivers with sluggish to moderate flows. Those stream characteristics are also associated with the remaining members of the community. Several species are also associated with increased nutrients because of food source requirements (algae). In general, the community collected at this site is typical for streams of this magnitude.

No F.D.A. action levels were exceeded in fish tissue at these stations in 1982 or 1983.

UPPER CUMBERLAND RIVER BASIN

The Upper Cumberland River basin is located in southeastern Kentucky in the Appalachian Plateaus and Interior Low Plateaus Provinces, with the headwaters draining slopes of the Cumberland Mountains and the Pine Mountain overthrust. The river drains Pennsylvanian sandstone in the Appalachian Plateaus and Mississippian limestone deposits in the Interior Low Plateaus. The mainstem of the river is formed at the junction of Clover Fork, Martins Fork, and Poor Fork at Harlan, Kentucky. Flowing in a generally westward direction, the river cuts across the Cumberland Plateau and Pottsville Escarpment to enter the Interior Low Plateaus Province before turning south to enter Tennessee. There are four major impoundments in the basin; Cumberland, Dale Hollow, Laurel River and Martins Fork reservoirs. There are 2,161 miles of stream in the basin depicted on the USGS hydrologic unit map. Total drainage area in Kentucky is 5,077 square miles. Principal tributaries are the Big South Fork of the Cumberland River with a drainage area of 1382 square miles and the Rockcastle River with a drainage area of 763 square miles. Other major tributaries include Clear Fork, Buck Creek, and the Laurel River.

Topography of the basin varies greatly. The eastern portion lies in the steep, rugged terrain of the Cumberland Mountains. The central portion lies in the Cumberland Plateau region which is characterized by steep undulating to rolling land. The northwestern tip of the basin is located in the Knobs region, an area of large hills with steep slopes. Extreme western portions of the basin are within the Pottsville Escarpment and the eastern subsection of the Highland Rim, which are generally upland plains with low relief and karst topography.

Average slope of the streams throughout the basin is 14 feet/mile with the main stem above Lake Cumberland averaging approximately 7 feet/mile.

Impacts

The Upper Cumberland River basin has been impacted by a variety of man's activities. The Cumberland Plateau portion of the basin has been heavily impacted by both deep and surface coal mining operations. Localized acid mine drainage, generally attributed to deep mining practices, has diminished in recent years due to an increase in surface mining. Acid mine drainage is now most prominent in portions of the Big South Fork of the Cumberland River.

Oil and natural gas drilling has occurred in the Big South Fork drainage since the late 1800's. In recent years, these operations have increased substantially in the Big South Fork subbasin and adjacent areas, resulting in an increase in brine impacts.

Impacts resulting from agricultural operations are limited on the Cumberland Plateaus, due to the lack of suitable land, but increase substantially as the river flows westward through the Interior Low Plateaus. Localized silvicultural operations are scattered through the basin, but are most abundant on the Cumberland Plateaus in and adjacent to the Daniel Boone National Forest. Silvicultural operations are also common in association with surface coal mining.

Domestic sewage pollution originates from small municipalities throughout the basin. These towns usually discharge treated effluents to small tributary streams that have low flows approaching zero. Generally, these streams are incapable of properly assimilating waste loads without a degradation of water quality. A notable example of this is Yellow Creek, which flows through Middlesboro. This small stream is heavily impacted by a tannery and a municipal wastewater treatment plant, in addition to siltation from coal mining operations.

Coal mining operations, oil and gas drilling, and municipal effluent discharges have impacted the aquatic biota throughout a major portion of the drainage. However, in some areas the aquatic life is quite diverse. A number of endangered species of fish and freshwater mussels are found in the basin. Four fish kills were reported from the basin in each of the reporting years (1982 and 1983). There are four ambient monitoring stations in the basin.

Problem Parameters

Fecal coliform bacteria and suspended solids were the major problem parameters in this basin. Copper and iron were also elevated. Chlordane was elevated in sediments at all sites.

Flow

The annual average discharge for the period of record (4 years) is 9,155 cfs for the Upper Cumberland at mile point 459.4. Mean discharge for water year 1982 was slightly above the annual average discharge (+1%). During water year 1983, mean discharge was 16% above annual average.

Hydrologic Unit 05130101 - Upper Cumberland River above Rockcastle River

A total of 955 miles of streams draining 1,999 square miles in Kentucky comprise this hydrologic unit. Major urban centers include Harlan (pop. 3,024), Pineville (pop. 2,599), London (pop. 4,002), Corbin (pop. 8,075), Williamsburg (pop. 5,560), and Middlesboro (pop. 12,251). Recreation centers include Laurel Reservoir, Levi Jackson State Park, Pine Mountain State Park, Cumberland Gap National Park, Martins Fork Reservoir, Kingdom Come State Park, and Cumberland Falls State Park. Two water quality monitoring stations are located in this hydrologic unit: Cumberland River at Pineville and Cumberland River at the Falls.

One hundred twelve miles have been recommended for stream use designations. Poor Fork of the Cumberland River and its tributaries from mile point 694.2 to its origin have been recommended for Aquatic Life/Warmwater Aquatic Habitat and Primary and Secondary Contact Recreation uses. Bad Branch, a stream not listed on the hydrologic unit map, has been recommended for Aquatic Life/Coldwater Aquatic Habitat use since it supports a reproducing trout fishery. The cities of Cumberland (RMI 719.57) and Harlan (RMI 694.36) withdraw drinking water from the Poor Fork and those points of withdrawal have been recommended for Domestic Water Supply. Violations of Kentucky Surface Water Standards for undissociated hydrogen sulfide, phthalate esters, mercury, aluminum and fecal coliform bacteria were observed during a stream designation study. Extensive coal mine operations occur throughout most of this watershed and municipal waste discharges from the aforementioned cities have impaired water quality and/or destroyed or reduced aquatic habitat throughout most of the drainage. For this reason, this stream reach is considered to partially support the recommended stream uses.

The Yellow Creek drainage in the vicinity of Middlesboro, Kentucky has been recommended for Aquatic Life/Warmwater Aquatic Habitat and Primary and Secondary Contact uses. The Yellow Creek drainage contains 46 stream miles. Also, Fern and Cannon Creek lakes (not listed on the hydrologic unit map) have been recommended for designation as Domestic Water Supply use. Two additional streams not listed on the hydrologic unit map, Shillalah Creek and Sugar Run, support a wild trout fishery and are recommended for Aquatic Life/Coldwater Aquatic Habitat use. A stream use designation study and historical data indicate that Kentucky Surface Water Standards for fecal coliform bacteria, phthalate esters, aluminum, mercury, iron, dissolved oxygen, pH and chromium have been violated. Extensive coal mining has occurred

throughout the drainage, degrading essential aquatic habitats. The city of Middlesboro has discharged municipal waste effluent of poor quality for years, which has resulted in eliminating or reducing aquatic life in the lower 15 miles of Yellow Creek. For these reasons, Yellow Creek is considered to be impaired and does not support the recommended designated uses.

o Dissolved Oxygen (DO) (mg/l)

For the reporting period DO ranged from a minimum of 5.2 to a maximum of 15.8 with a mean range of 9.2 to 9.3 and a median range of 8.4 to 9.2.

o pH

For the reporting period pH ranged from a minimum of 6.7 to a maximum of 8.3 with a mean range of 7.3 to 7.4 and a median range of 7.3 to 7.4. For the period of record (1979-1983) pH ranged from a minimum of 6.7 to a maximum of 8.8 with a mean range of 7.4 to 7.6 and a median range of 7.4 to 7.5.

o Acidity (mg/l)

For the reporting period acidity ranged from a minimum of 1.2 to a maximum of 30.8 with a mean range of 6.8 to 8.3 and a median range of 3.8 to 5.3. For the period of record (1979-1983) acidity ranged from a minimum of 0.0 to a maximum of 33.6 with a mean range of 5.3 to 6.2 and a median range of 4.0 to 4.6.

o Alkalinity (mg/l)

For the reporting period alkalinity ranged from a minimum of 21.0 to a maximum of 162.0 with a mean range of 54.0 to 68.4 and a median range of 46.4 to 57.6. For the period of record (1979-1983) alkalinity ranged from a minimum of 21.0 to a maximum of 207.0 with a mean range of 54.3 to 75.9 and a median range of 50.0 to 67.0.

o Conductivity (µmhos/cm)

For the reporting period conductivity ranged from a minimum of 161.0 to a maximum of 732.0 with a mean range of 278.0 to 325.0 and a median range of 242.0 to 271.0. For the period of record (1979-1983) conductivity ranged from a minimum of 104.0 to a maximum of 732.0 with a mean range of 273.8 to 336.3 and a median range of 254.0 to 294.0.

o Chlorides (mg/l)

For the reporting period chlorides ranged from a minimum of 1.2 to a maximum of 24.2 with a mean range of 6.7 to 7.0 and a median range of 5.3 to 5.4. For the period of record (1979-1983) chlorides ranged from a minimum of 1.2 to a maximum of 38.6 with a mean range of 6.5 to 7.7 and a median range of 5.1 to 5.8.

o Sulfates (mg/l)

For the reporting period sulfates ranged from a minimum of 37.3 to a maximum of 179.0 with a mean range of 72.5 to 77.3 and a median range of 59.3 to 61.9. For the period of record (1979-1983) sulfates ranged from a minimum of 25.0 to a maximum of 179.0 with a mean range of 66.9 to 78.3 and a median range of 62.0 to 73.0.

o NO₂-NO₃-N (mg/l)

For the reporting period NO₂-NO₃-N ranged from a minimum of 0.01 to a maximum of 1.17 with a mean range of 0.32 to 0.462 and a median range of 0.350 to 0.440. For the period of record (1979-1983) NO₂-NO₃-N ranged from a minimum of 0.01 to a maximum of 1.3 with a mean range of 0.33 to 0.43 and a median range of 0.35 to 0.43.

o Total Phosphorus (mg/l)

For the reporting period total phosphorus ranged from a minimum of 0.020 to a maximum of 0.355 with a mean range of 0.068 to 0.091 and a median range of 0.091 to 0.075. For the period of record (1979-1983) total phosphorus ranged from a minimum of 0.005 to a maximum of 0.42 with a mean range of 0.073 to 0.091 and a median range of 0.046 to 0.070.

o Fecal Coliform

Fecal coliform standards were exceeded 69% of the time during the reporting period. The highest percentage of violations occurred at the Cumberland River at Pineville station.

Hydrologic Unit 05130102 - Rockcastle River

A total of 399 miles of streams draining 763 square miles comprise this hydrologic unit. Major urban centers include Mt. Vernon (pop. 2,334), McKee (pop. 759), and Livingston (pop. 334). Recreation centers include Woods Creek Lake and Lake Linville. One water quality monitoring station is located in this hydrologic unit: Rockcastle River at Billows.

o Dissolved Oxygen (DO) (mg/l)

For the reporting period DO ranged from a minimum of 5.5 to a maximum of 12.4 with a mean of 8.6 and a median of 8.3.

o pH

For the reporting period pH ranged from a minimum of 6.6 to a maximum of 8.9 with a mean of 7.4 and a median of 7.4. For the period of record (1979-1983) pH ranged from a minimum of 6.6 to a maximum of 8.9 with a mean of 7.5 and a median of 7.5.

o Acidity (mg/l)

For the reporting period acidity ranged from a minimum of 1.5 to a maximum of 33.2 with a mean of 6.5 and a median of 5.0. For the period of record (1979-1983) acidity ranged from a minimum of 0.0 to a maximum of 33.2 with a mean of 5.3 and a median of 4.0.

o Alkalinity (mg/l)

For the reporting period alkalinity ranged from a minimum of 33.2 to a maximum of 94.0 with a mean of 57.3 and a median of 49.9. For the period of record (1979-1983) alkalinity ranged from a minimum of 33.2 to a maximum of 95.6 with a mean of 57.8 and a median of 58.0.

o Conductivity (µmhos/cm)

For the reporting period conductivity ranged from a minimum of 107.0 to a maximum of 562.0 with a mean of 204.6 and a median of 177.0. For the period of record (1979-1983) conductivity ranged from a minimum of 107.0 to a maximum of 562.0 with a mean of 194.3 and a median of 175.0.

o Chlorides (mg/l)

For the reporting period chlorides ranged from a minimum of 2.9 to a maximum of 7.3 with a mean of 4.4 and a median of 4.4. For the period of record (1979-1983) chlorides ranged from a minimum of 1.4 to a maximum of 13.4 with a mean of 4.5 and a median of 3.8.

o Sulfates (mg/l)

For the reporting period sulfates ranged from a minimum of 14.7 to a maximum of 44.6 with a mean of 28.4 and a median of 29.0. For the period of record (1979-1983) sulfates ranged from a minimum of 14.0 to a maximum of 134.0 with a mean of 29.4 and a median of 27.5.

o NO₂-NO₃-N (mg/l)

For the reporting period NO₂-NO₃-N ranged from a minimum of 0.105 to a maximum of 0.750 with a mean of 0.390 and a median of 0.420. For the period of record (1979-1983) NO₂-NO₃-N ranged from a minimum of 0.05 to a maximum of 0.82 with a mean of 0.369 and a median of 0.345.

o Total Phosphorus (mg/l)

For the reporting period total phosphorus ranged from a minimum of 0.013 to a maximum of 0.183 with a mean of 0.044 and a median of 0.032. For the period of record (1979-1983) total phosphorus ranged from a minimum of 0.005 to a maximum of 0.26 with a mean of 0.036 and a median of 0.023.

o Fecal Coliform

Fecal coliform standards were exceeded 4% of the time during the reporting period.

o Biological

The invertebrate collections from the Rockcastle River station expressed considerable diversity in feeding types and species composition. The available habitats for invertebrates are exceptional, both in abundance and types. There are no obvious influences upon the benthic community in relation to water quality. Siltation and nutrient enrichments are not detectable. This site also supports a diverse freshwater mussel fauna that includes 18 species collected to date.

No F.D.A. action levels were exceeded in fish tissue at this station in 1982 or 1983.

Hydrologic Unit 05130103 - Cumberland River below Rockcastle River

A total of 589 miles of streams draining 1,753 square miles comprise this hydrologic unit. Major urban centers include Monticello (pop. 5,677), Jamestown (pop. 1,441), Somerset (pop. 10,641), Burkesville (pop. 2,051), and Russell Springs (pop. 1,831).

Recreation centers include Lake Cumberland. One water quality monitoring station is located in this hydrologic unit: Cumberland River at Burkesville.

A total of 25.5 miles encompassing the Beaver Creek drainage near Monticello, Kentucky have been recommended for stream use designations. The entire Beaver Creek system has been recommended for Primary and Secondary Contact Recreation use. Approximately 5 miles of Beaver Creek supports a put and take trout fishery, therefore, it is recommended for Aquatic Life/Coldwater Aquatic Habitat use. The remainder of the drainage is recommended for Aquatic Life/Warmwater Aquatic Habitat use. A stream use designation study on the Beaver Creek system revealed Kentucky Surface Water Standard violations for free cyanide, phthalate esters, aluminum, iron and mercury. The Beaver Creek system has excellent habitat diversity and support a speciose aquatic flora and fauna. Except for a one mile reach of Elk Creek below the Monticello wastewater treatment plant, the entire drainage is considered to support the recommended designations. This one mile reach partially supports the recommended designated use.

o Dissolved Oxygen (DO) (mg/l)

For the reporting period DO ranged from a minimum of 6.4 to a maximum of 12.4 with a mean of 9.7 and a median of 10.2.

o pH

For the reporting period pH ranged from a minimum of 7.0 to a maximum of 8.0 with a mean of 7.4 and a median of 7.4. For the period of record (1979-1983) pH ranged from a minimum of 6.5 to a maximum of 8.0 with a mean of 7.4 and a median of 7.4.

o Acidity (mg/l)

For the reporting period acidity ranged from a minimum of 1.0 to a maximum of 12.5 with a mean of 5.2 and a median of 4.2. For the period of record (1979-1983) acidity ranged from a minimum of 1.0 to a maximum of 35.0 with a mean of 6.7 and a median of 4.0.

o Alkalinity (mg/l)

For the reporting period alkalinity ranged from a minimum of 29.5 to a maximum of 363.0 with a mean of 60.2 and a median of 45.6. For the period of record (1979-1983) alkalinity ranged from a minimum of 29.5 to a maximum of 363.0 with a mean of 55.3 and a median of 49.6.

o Conductivity (µmhos/cm)

For the reporting period conductivity ranged from a minimum of 139.0 to a maximum of 198.0 with a mean of 170.9 and a median of 166.0. For the period of record (1979-1983) conductivity ranged from a minimum of 100.0 to a maximum of 198.0 with a mean of 163.9 and a median of 165.0.

o Chlorides (mg/l)

For the reporting period chlorides ranged from a minimum of 1.1 to a maximum of 9.1 with a mean of 4.05 and a median of 4.1. For the period of record (1979-1983) chlorides ranged from a minimum of 1.1 to a maximum of 9.1 with a mean of 3.8 and a median of 3.6.

- Sulfates (mg/l)

For the reporting period sulfates ranged from a minimum of 13.8 to a maximum of 38.6 with a mean of 29.5 and a median of 30.1. For the period of record (1979-1983) sulfates ranged from a minimum of 11.0 to a maximum of 38.6 with a mean of 28.5 and a median of 29.9.

- NO₂-NO₃-N (mg/l)

For the reporting period NO₂-NO₃-N ranged from a minimum of 0.225 to a maximum of 0.565 with a mean of 0.418 and a median of 0.420. For the period of record (1979-1983) NO₂-NO₃-N ranged from a minimum of 0.225 to a maximum of 0.600 with a mean of 0.405 and a median of 0.400.

- Total Phosphorus (mg/l)

For the reporting period total phosphorus ranged from a minimum of 0.006 to a maximum of 0.042 with a mean of .014 and a median of 0.012. For the period of record (1979-1983) total phosphorus ranged from a minimum of 0.005 to a maximum of 0.150 mg/l with a mean of 0.016 and a median of 0.012.

- Fecal Coliform

Fecal coliform standards were exceeded 17% of the time during the reporting period.

Hydrologic Unit 05130104 - South Fork Cumberland River

A total of 193 miles of streams draining 404 square miles comprise this hydrologic unit. The major urban center is Whitley City. Recreation centers include Big South Fork Wild River and Rock Creek Gorge. One water quality monitoring station is located in this hydrologic unit: South Fork Cumberland River at Yamacraw.

- Dissolved Oxygen (DO) (mg/l)

For the reporting period DO ranged from a minimum of 5.2 to a maximum of 15.2 with a mean of 8.9 and a median of 9.1.

- pH

For the reporting period pH ranged from a minimum of 6.4 to a maximum of 7.7 with a mean of 7.0 and a median of 6.9. For the period of record (1979-1983) pH ranged from a minimum of 6.4 to a maximum of 8.7 with a mean of 7.0 and a median of 7.0.

- Acidity (mg/l)

For the reporting period acidity ranged from a minimum of 1.6 to a maximum of 27.3 with a mean of 5.4 and a median of 4.0. For the period of record (1979-1983) acidity ranged from a minimum of 0.0 to a maximum of 27.3 with a mean of 4.0 and a median of 3.2.

- Alkalinity (mg/l)

For the reporting period alkalinity ranged from a minimum of 9.0 to a maximum of 60.4 with a mean of 22.5 and a median of 19.3. For the period of record (1979-1983) alkalinity ranged from a minimum of 9.0 to a maximum of 60.4 with a mean of 22.3 and a median of 20.0.

o Conductivity (μmhos/cm)

For the reporting period conductivity ranged from a minimum of 87.0 to a maximum of 356.0 with a mean of 172.0 and a median of 132.0. For the period of record (1979-1983) conductivity ranged from a minimum of 79.0 to a maximum of 356.0 with a mean of 164.9 and a median of 141.0.

o Chlorides (mg/l)

For the reporting period chlorides ranged from a minimum of 2.6 to a maximum of 34.4 with a mean of 6.8 and a median of 4.3. For the period of record (1979-1983) chlorides ranged from a minimum of 1.2 to a maximum of 34.4 with a mean of 5.3 and a median of 3.9.

o Sulfates (mg/l)

For the reporting period sulfates ranged from a minimum of 21.8 to a maximum of 97.7 with a mean of 47.0 and a median of 33.5. For the period of record (1979-1983) sulfates ranged from a minimum of 19.3 to a maximum of 102.0 with a mean of 47.5 and a median of 38.1.

o NO₂-NO₃-N (mg/l)

For the reporting period NO₂-NO₃-N ranged from a minimum of 0.015 to a maximum of 0.32 with a mean of 0.174 and a median of 0.180. For the period of record (1979-1983) NO₂-NO₃-N ranged from a minimum of 0.015 to a maximum of 0.425 with a mean of 0.176 and a median of 0.190.

o Total phosphorus

For the reporting period total phosphorus ranged from a minimum of 0.009 to a maximum of 0.078 with a mean of 0.036 and a median of 0.028. For the period of record (1979-1983) total phosphorus ranged from a minimum of 0.004 to a maximum of 0.235 with a mean of 0.038 and a median of 0.026.

o Fecal Coliform

Fecal coliform standards were exceeded 8% of the time during the reporting period.

Hydrologic Unit 05130105 - Dale Hollow Lake Tributaries

A total of 27 miles of streams draining 119 square miles comprise this hydrologic unit. The major urban center is Albany (pop. 2,083). Recreation centers include Dale Hollow Lake. There are no water quality monitoring stations in this unit.